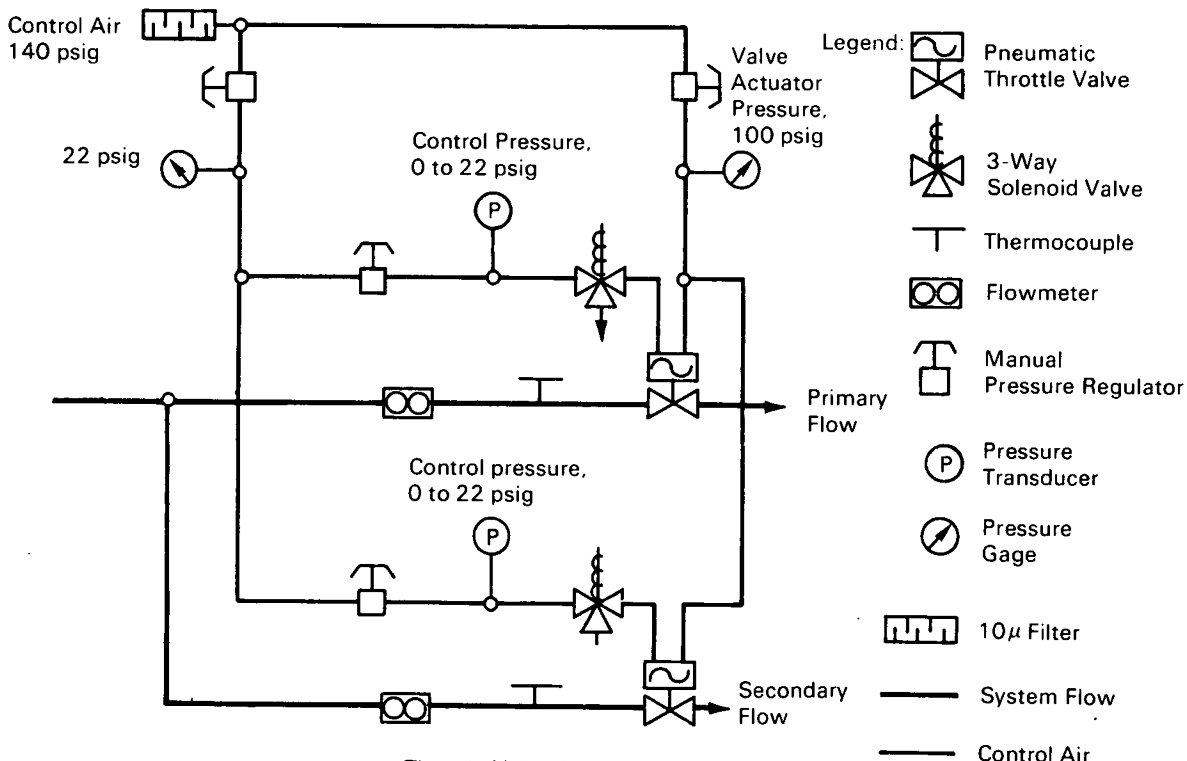
NASA TECH BRIEF

Precision Control System for Engine Fuel



Throttle Valve Control System Schematic

This control system represents a potentially useful new method of controlling two or more pneumatically operated metering valves from a common pneumatic source without interaction between the valve controls. The information should interest personnel engaged in the design and maintenance of pneumatic, hydraulic, and electrical control systems.

The innovation affords independent metering of liquid from a single source to two concurrent applications. Downstream of the system main valve, the flow is divided. Each line is provided with a variable position control valve which is pneumatically controlled to provide independent regulation of the liquid flow rate. Positioning of the valve plugs is obtained through the use of a constant loading pressure and a variable control pressure, as shown in the figure. The valve position is indicated by a linear slide transducer. Thus, after system calibration, the valve position can be controlled predictably, and any reasonable change in either flow can be effected. Calibration

(continued overleaf)

and testing demonstrated a virtually complete absence of interaction between the two valves and the corresponding flow rates.

In one proposed application, two separate flow rates of the fuel diborane (B_2H_6) had to be controlled independently with accuracy, repeatability, and convenience, from a single tank and main line. The purpose of the flow control system was to provide accurate metering of both the main engine fuel injector (primary) flow and the separately manifolded film coolant (secondary) flow from the same tank of diborane. The throttle valves performed the dual role of shutoff valves and calibrated, variable position orifices.

Contoured valve plugs had to be specially designed to provide accurate throttle control over the specified ranges of flow. Extensive calibration and over 50 tests proved the effectiveness of the system. Time for stable flow appeared dependent only on the line and manifold volume downstream of the valves and not on damping of valve position fluctuations. Stable flows were obtained within 0.5 sec of throttle valve operation from full closed to test position.

To effect meaningful calibration and testing, a closed loop, 1-butene system was temporarily plumbed into the facility just upstream of the dual line sections, for the purpose of calibrating the throttle valves. The fuel simulant, 1-butene, was used because of its low viscosity and density and its compatibility with diborane.

Calibrations were made to determine throttle valve position versus flow rate and pressure drop for the test conditions to be encountered. Each valve was calibrated separately to determine if suitable ranges of flow could be obtained with a given common tank pressure. Then both sides were operated together to determine the effect of varying one valve position on the flow through the other valve.

Flow rate was plotted against throttle valve position. In the tests, the objective was to determine the flow rate interdependence of the two valves, with a constant upstream (tank) pressure, to determine how much effect a variation in one valve had on the flow through the other. Consequently, a sequence of seven flows was made with the primary throttle valve position fixed and the secondary valve position varied systematically. All of the primary flow rates, corresponding to the seven tests, fell within the range of the initial data point. In a similar manner, a sequence of tests was made holding the secondary throttle valve fixed in position and varying the primary valve. The results again showed that a constant flow rate was maintained through the fixed valve.

Note:

No additional documentation is available. Specific questions, however, may be directed to:

Technology Utilization Officer
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No patent action is contemplated by NASA.

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